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OF THE

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No. 7

Lieut.-General J. F. TENNANT, R.E., C.I.E., F.R.S., President,
in the Chair.

Alfred Henry Fison, D.Sc., University College, London,
W.C.;

Thomas Gordon, F.R. Met. Soc., 9 Scotch Street, White-
haven;

George E. Hale, B.Sc., 4545, Drexel Boulevard, Chicago,
U.S.A.;

were ballotted for and duly elected Fellows of the Society.

The following candidate was proposed for election as a Fellow of the Society, the name of the proposer from personal knowledge being appended:—

Oliver Joseph Lodge, D.Sc., LL.D., F.R.S., Professor of
Physics, University College, Liverpool (proposed by G.
H. Darwin).

Seventy-seven presents were announced as having been received since the last meeting, including amongst others:—

E. Dunkin, *The Midnight Sky*: new edition, presented by the author; Leander McCormick Observatory publications, vol. i. part 5 (*Durchmusterung* — 23°), presented by the Observatory; Harvard College Observatory, *Annals*, vols. xxiii. part 1, and xxvii. (*Observations with the Meridian Photometer*, 1882–88, and *The Draper Catalogue of Stellar Spectra*), presented by the Observatory; C. A. Young, *Lessons in Astronomy*, including *Uranometry*, presented by E. Arnold; Munich Obser-

vatory, *Neue Annalen*, Band i., *Erstes Münchener Sternverzeichnis* von 33082 Sternen, presented by the Observatory ; Pulkowa Observatory, *Catalog von 5634 Sternen aus den Beobachtungen 1874-80*, presented by the Observatory ; Photograph of cluster in *Perseus*, made at the Lick Observatory, presented by E. S. Holden.

Further Experience regarding the Magnitude of Stars as obtained by Photography in the Oxford University Observatory. By the Rev. Professor C. Pritchard, D.D., F.R.S.

Notwithstanding all that passed at the recent meeting of the Paris Congress, doubt seems still to exist as to the photographic representation of the photometric magnitudes of the fainter stars, and of the time required for the impression of these faint stars on a photographic film. For instance, the experience of the Oxford Observatory, founded on the examination and discussion of some thirty-six plates, proves that the time necessary for photographing a star of the 11th magnitude, in a condition admitting of bisection and measurement, is on the very finest nights 200 seconds ; whereas the experience of Greenwich, founded, it is believed, on the examination of a smaller number of plates, is that, under the same favourable atmospheric conditions, a star of the 11th magnitude may be photographed and subsequently measured after an exposure of only 96 seconds. Under less favourable meteorological conditions, it has been found necessary at Oxford, in order to photograph stars of the 11th magnitude, to prolong the exposure to 5 and even 8 minutes, while at Greenwich an exposure of 4 minutes is the longest contemplated.

I have considered it desirable to examine this question in still greater detail than in the paper which I communicated to the Paris Congress, and I may say that the general result has been to completely confirm the conclusions which I had previously obtained. The methods which I adopted have been twofold. In the first place, I photographed a district, delineated in the charts of the late Professor Peters, with exposures of 3, 4, 6, 8, and 15 minutes. These charts were chosen because they give the configurations of a considerable number of reputed 11th magnitude stars, and therefore permitted an easy comparison. The result of the examination of the plates was as follows :

After 3 min. exposure, 31 per cent. of Peters' stars were photographed.

4	,	42	"	"	"
6	"	62	"	"	"
8	,	78	"	"	"

But some stars were not visible after 15 minutes' exposure. A photometric determination of the brilliancy of some of the fainter stars with the wedge photometer proved, that

After 4 min. exposure, stars of 10.5 mag. were measurable.

6	"	"	11.0 or 11.2	"
8	"	"	11.5 or 11.7	"

This proved that many stars on Professor Peters' charts were fainter than the 11th magnitude, though no symbol indicating a fainter magnitude is used in the construction of the chart.

For this reason, and also because the charts do not extend to an altitude at which the Oxford zone will have to be photographed, it was determined to take an additional trial-plate in the actual zone, and photometrically to measure the magnitude of stars of approximately the 11th magnitude. The night chosen was exceptionally fine and the definition much above the average. An examination of the plate proved that 11th magnitude stars were measurable after 4 minutes' exposure, and possibly after 3 minutes' exposure. It was considered that $3\frac{1}{2}$ minutes or 210 seconds would on that night have been sufficient to effectually record the places of stars of the 11th magnitude.

These discrepancies, if discrepancies they can properly be called, between the results here given and those recorded by the Astronomer Royal may to some extent be explained by the superiority of the Greenwich instrument over that in use at Oxford. The images produced by the Greenwich object-glass are exceptionally small and condensed, and are said to be readily discernible when having a diameter of $2''.5$, whereas on the Oxford plates the diameters of the smallest images sufficiently distinct for measurement vary from $3''.2$ to $3''.5$. The great accuracy of the driving mechanism of the Greenwich Equatoreal, rendering for the most part the uncertain and often exaggerated action of the manual control unnecessary, is doubtless an assistance in producing the small black images characteristic of the Greenwich plates, as exhibited at the Paris Congress. Reference is here made to this fact solely with the view of accounting for the discrepancies which unquestionably exist in the time recorded as necessary for the impression of images of a specified magnitude, such as the 11th. Fortunately, the Congress have recognised the difficulty, and arrived at a practical solution, by recommending each Observatory to determine in its own particular case the time necessary to impress stars of the 11th magnitude on the sensitised film.

The plan proposed by the Congress is that in each Observatory a star of the 11th magnitude shall be artificially formed by reducing a star of the ninth two units of brightness, by means of a metallic gauze of a definite mesh, supplied to each Observatory, and placed in front of the object-glass. Moreover, a small catalogue is to be furnished to each Observatory of stars

definitely accepted as of the ninth magnitude. As I have myself been placed by the Congress on a committee for the execution of this scheme, I shall, if it be thought desirable by my colleagues, be perfectly ready to furnish the catalogue, and also to examine the gauze necessary for the purpose described. At the same time, I think it will greatly facilitate the object in view, if I were to supplement the necessary list of stars of the 9th magnitude by another catalogue of the 11th magnitude photometrically determined, selected from the same typical areas as those in which the stars of the 9th magnitude will be found. For general convenience this catalogue of stars will be selected from a zone about 8° north of the Equator. The magnitudes of all these stars will be determined at Oxford by the application of the wedge photometer, keeping strictly in view the average scale found in Argelander's work.

The foregoing remarks apply solely to the stars which are intended to form the International Catalogue of all stars to the 11th magnitude, but the Congress have decided that there is to be a chart formed containing stars of a much inferior brightness. It was originally presumed that this order of faintness was to extend to magnitude 14, as defined by the 1887 Congress. Experience, however, has shown that stars of the photometric magnitude 14 require a time of exposure which would render so extensive a chart practically unattainable, and this amount and uncertainty of the time required seems to have led the Congress to the practical issue conveyed by the following minute:—

‘Le comité permanent indique quarante minutes comme la durée de la pose pour les clichés de la carte, dans les conditions atmosphériques moyennes à Paris, et avec les plaques Lumière actuellement en usage à Paris.’

As a matter of fact, I believe that no star of magnitude 14 has hitherto been photometrically determined; at all events, I have never been able myself to measure a star of this degree of faintness. The wedges employed for stars, recorded in the *Uranometria Nova Oxoniensis*, when applied to the Oxford 12½-inch object-glass, extinguish stars between the 9th and 10th magnitude, and are inapplicable to fainter objects. Under these circumstances, I requested Mr. Hilger to furnish me with a wedge capable of determining the magnitude of stars of inferior brightness; and he, not without great difficulty, has constructed for me a wedge applicable to stars a little fainter than magnitude 12. If such a wedge could be applied to an object-glass of twice the aperture of that of the Oxford equatoreal, it would be available for the extinction of stars of the approximate magnitude of 13.5, and if such a wedge were applied to an object-glass three times the aperture—that is, to about the size of the Lick refractor—it might possibly be applicable to the photometric determination of stars about magnitude 14.5. Such,

then, is the state of the case in reference to existing photometric apparatus, exhibiting the extreme difficulty of the accurate determination of magnitudes so faint. The word "approximately" is here used because it is by no means probable that the light admitted by a thick and compound object-glass is accurately proportioned to the area of glass exposed.

Yet, and notwithstanding these statements, it is quite certain that astronomers, including myself, have repeatedly photographed in the Pleiades stars unquestionably fainter than magnitude 14. In one plate of the Pleiades, taken at Oxford, with a three hours' exposure, I have no manner of doubt but that more than one hundred stars fainter than the 14th are there visibly impressed, and it is equally certain that stars of the 14th magnitude have even been copied therefrom. Still, absolutely accurate measurements of these faint stars are, by me, at least, unattainable. The question, therefore, immediately arises, How can we speak definitely of the order of brightness of these faint Pleiades stars?

In the year 1887, in a paper printed in the Proceedings of the Royal Society, I believe I, for the first time, obtained a mathematical expression connecting photometric brightness with photographic diameter. The formula therein given is the equivalent of the now well-known expression:—

$$M = a - b \log. D.$$

Supposing, then, that proper measurements and this formula are applied to stars on the Pleiades plate already referred to or any other suitable plate, it is possible to determine the constants a and b for that plate, so as to furnish a curve reaching from magnitude 4 to magnitude 12, the stars employed being all photometrically determined. In the actual case quoted, the formula is

$$M = 19.23 - 9.67 \log. D.$$

That represents all stars to magnitude 12, and theoretically is applicable to stars of a fainter magnitude; but the expediency of thus pushing the formula beyond a magnitude, unascertained by a photometric process, is not established.

To test the applicability of the formula to the determination of the magnitude of stars fainter than those employed in deducing it, I have taken the measured diameters of stars not fainter than the 9th magnitude, and from the expression thus deduced I have computed the diameters of stars of the 11th magnitude which could be directly compared with the measured quantities. I have also, with a curve founded on measures of stars brighter than the 10th magnitude, deduced the diameters of stars of the twelfth order of brightness. In each case I have found a very close agreement with the diameters read from the curve, the deviation not being greater than is the uncertainty of the interpolating curve itself. From these facts I conclude that

it is safe to trust the deductions from the equation for at least two magnitudes beyond those employed in deducing it, and that consequently an adequate appreciation of stars of the 14th magnitude is possible.

But when it was originally proposed as a part of the international project to attain a photographic chart of the heavens, including stars of the 14th magnitude, it must not for a moment be overlooked that this magnitude 14 (limited by the definition attached to it by the Congress) did not necessarily mean magnitude 14 photometrically determined.

The definition of photographic magnitude made in 1887 implied that an increase in the intensity of the source of light was exactly equivalent to increasing the time of exposure in the same proportion. I am not disposed to admit or to controvert the general proposition. It certainly wears a general aspect of probability, but if the result of exposure of a plate to stars be measured by the diameters of the discs impressed, which seems to me the only adequate and practical method of measuring the photographic action, I then doubt the proposition altogether. The actinic action must be regarded in its entirety, and surely extends not to the area of the blackened disc alone, but to its depth and its mass. The visibility of the stars on the film, however, depends entirely on the diameter of the disc, though in very feeble stars the colour of the disc is no doubt of importance.

In order to ascertain practically the connection between magnitude and time of exposure, a series of Pleiades plates were taken with exposures of 20^s , 50^s , $2^m 5^s$, and so on up to 32^m , each of these exposures being $2\frac{1}{2}$ times that of the preceding, and consequently representing the steps of the conventional consecutive magnitudes. The diameters of the discs of the same star with these various successive exposures were then measured, wherein it is evident, if the diameter be assumed as the measure of actinic action, that the diameter of a star of the 3rd magnitude with the shortest exposure will be the same as that of the 4th magnitude exposed for 2.5 times as long, and the same rule will obtain with feebler magnitudes exposed for a proportionate longer time, it being well understood that the trials extend over a considerable number of stars, but for obvious reasons situated as near the centre of the plate as possible. The invariable result is that the fainter stars require a much longer exposure than that implied by the corresponding powers of 2.5, in order to obtain equality of diameter with the brighter stars. For example, a star of the 5th magnitude with an exposure of 50^s has a diameter of 9 div., but a star of the 9th magnitude exposed for $(2.5)^4 \times 50^s$ has a diameter of only 7 div. The following table exhibits the average results of many measurements of the diameters of star-images. The first two columns give respectively the mean photographic and photometric magnitudes of the stars as determined either from the measured diameter of the

star disc or the wedge photometer. It may be added that the star magnitudes in either column accord very well with those given by other authorities. The remaining columns give the diameters of the measured discs expressed in parts of the scale.

Table showing the mean diameters of groups of stars, given with exposures varying by successive powers of 2.5.

Mean Photographic Magnitude.	Mean Photometric Magnitude.	Diameter, after an exposure of					
		s 20 div.	s 50 div.	m s 2 5 div.	m s 5 12 div.	m 13 div.	m s 32 30 div.
3.46	3.2	9.6	...	...	...	...	...
4.39	4.2	8.2	9.5	...	...	...	...
5.47	5.4	6.25	7.85	9.15	...	...	...
6.51	6.5	4.37	5.90	7.20	8.62	...	...
7.43	7.4	...	3.80	4.90	6.27	7.93	...
8.52	8.4	...	...	3.45	4.45	5.65	7.05
9.46	9.5	...	...	...	3.30	4.4	5.60

The inspection of this representative table is a sufficient indication that the time required for the impression of a star of the 9th magnitude, for example, required to have a definite diameter is by no means sufficiently determined by the continued multiplication of the time required by a brighter star by the appropriate power of 2.5.

It will be seen from this that when the International Committee determined to construct a chart of stars with an exposure of forty minutes, or thereabouts, which time was determined on a certain hypothesis, it must not be expected that the 14th magnitude, as ordinarily or photometrically conceived, will necessarily appear on the plates. As to what order of faintness will be impressed on the average will not be known for a long time to come.

Before concluding this paper it may be as well to state that these numerous measurements of diameter have been completed at Oxford solely by the device of the wedge-lines ruled on a glass plate, described in *Monthly Notices*, vol. li., p. 223. On one plate alone some 800 stars were measured, and the magnitudes determined in about nine hours.

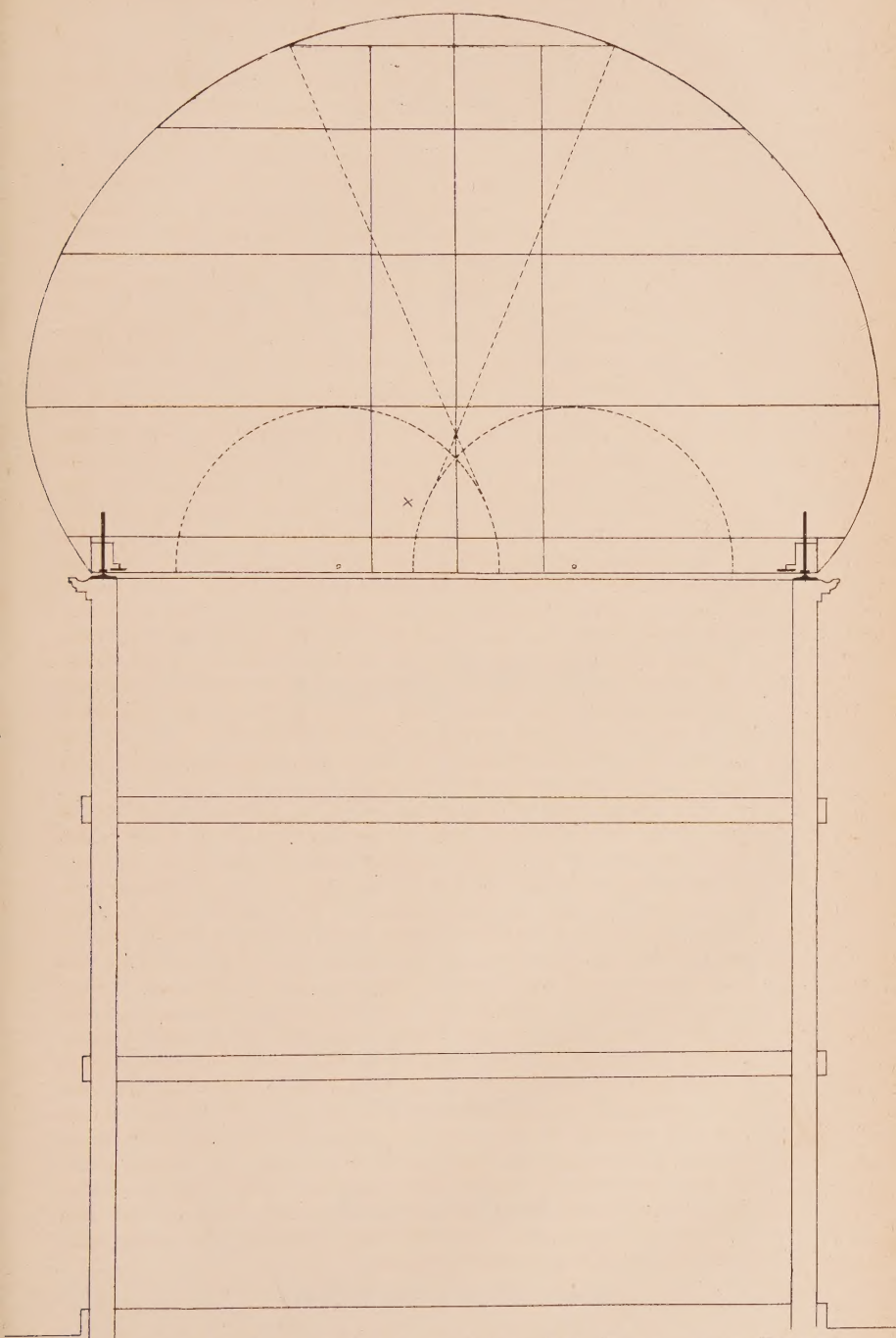
On a New Dome to be erected at the Royal Observatory, Greenwich.
By W. H. M. Christie, M.A., F.R.S., Astronomer Royal.

In the last Report of the Council (*Monthly Notices*, vol. li., p. 209) mention was made of a proposal to replace the existing wooden south-east dome (of cylindrical form) by an iron-framed dome of larger diameter, better suited to the new 28-inch refractor, which is now nearly ready. This proposal has received the sanction of the Admiralty, and the new dome is now being constructed by Messrs. T. Cooke and Sons, of York. As the conditions which it has to satisfy are peculiar, and as the plan proposed presents some novel features, it may be of interest to give a general description of it.

In order to accommodate the new 28-inch refractor of 28 feet focal length, a dome of 36 feet diameter is desirable; but as the external diameter of the circular wall-plate on which the dome runs is only 31 feet 4 inches, a peculiar form of dome is necessary. The form adopted is the surface generated by the revolution of an involute of a circle, 7 feet in diameter, with its centre in the plane of the rail, and 5 feet from the axis, the curve being completed near the apex by an arc of a circle (of 13 feet 3 inches radius) so that it cuts the axis at right angles. The diameter of the dome is 36 feet at a height of 7 feet above the rail, contracting to 31 feet at the plane of the rail. The varying curvature of the involute appears to be well adapted to the conditions, the contraction in the lower part of the dome to the diameter of 31 feet being rapid, owing to the sharp curvature, while the increasing curvature towards the apex gives ample height, and improves the appearance of the dome.

The framework of the dome is to be generally similar to that of the Lassell dome (constructed by Messrs. T. Cooke and Sons), consisting of T-iron vertical curved ribs, tied together by horizontal circular ribs (of T or angle iron) cut through at the shutter-opening on both sides of the zenith, the opening being framed with vertical girders connected by a strong broad-flanged rib at the apex of the dome. As the centre of the instrument is two feet south of the axis of the dome and tower, this connecting-rib would not interfere with the view of the zenith. The base of the framework will be a stiff circular girder, 18 inches deep, the section of the girder being a right-angled triangle, the hypotenuse of which is formed by the ribs and papier-mâché covering of the dome. Thus the dome virtually consists of two semi-domes, resting on the continuous circular girder, and tied together at the zenith. It is proposed to use some form of papier-mâché as the covering of the dome, the vertical T-ribs being outside the covering, with the flat face towards the paper, and the horizontal circular ribs inside, also with the flat face towards the paper.

Fig. 1.

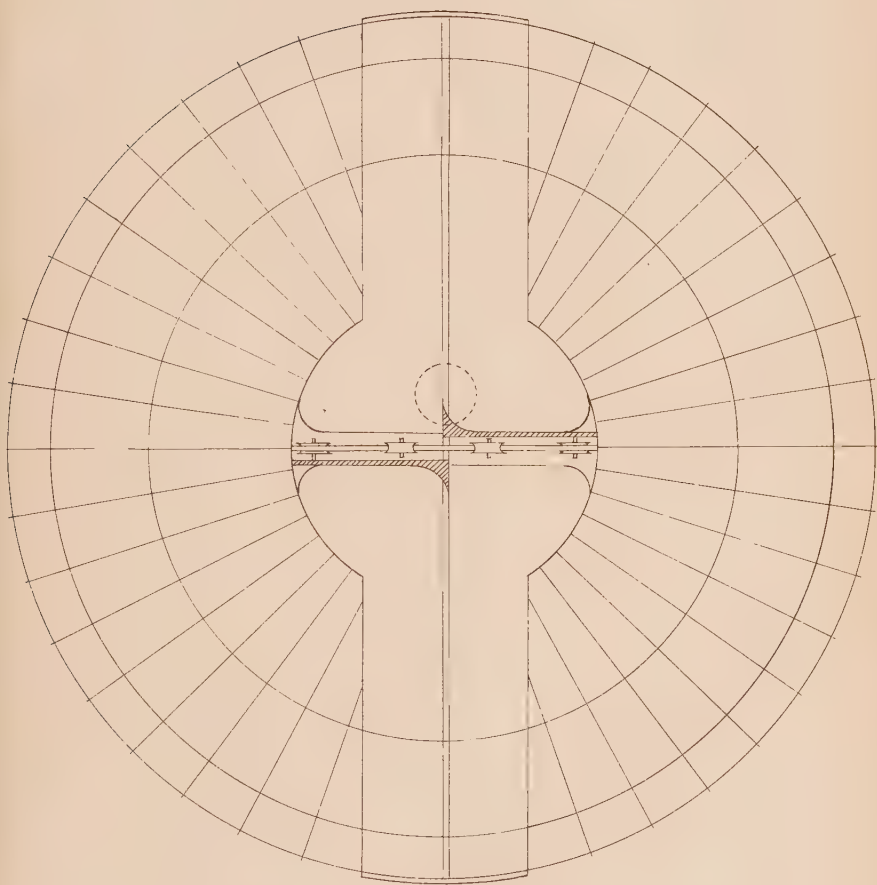


SECTIONAL ELEVATION OF NEW S.E. DOME AND TOWER,
ROYAL OBSERVATORY GREENWICH.



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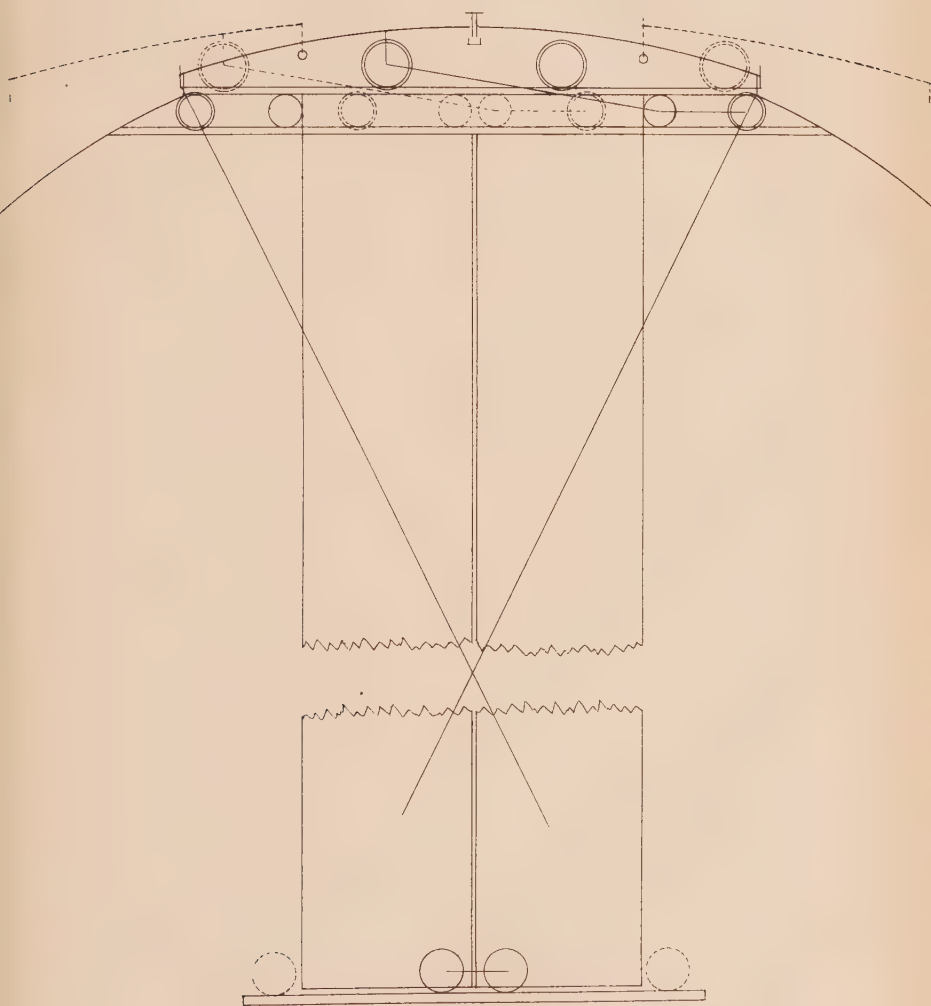
Fig. 2.



PLAN OF DOME

Scale $\frac{1}{8}$ inch to a foot. (nearly)

Fig. 3.



SECTIONAL ELEVATION OF SHUTTER.

Scale $\frac{1}{4}$ inch to a foot.

The revolving arrangements will be similar to those introduced by me in the Lassell dome, viz. a system of vertical rollers, about two feet in diameter, attached to the circular girder of the dome, and running freely on a planed horizontal rail, the bearing-surface of the rollers being slightly rounded, so as to avoid any drag. Excessive lateral motion from the force of the wind, or other cause, is prevented by horizontal rollers carried on the same bracket as the vertical rollers, and so adjusted as only to come into bearing occasionally against the vertical face of the rail, when required to keep the vertical rollers from running off the rail. This system has been found to work very satisfactorily in the case of the Lassell dome, which runs very lightly after seven years' use.

The arrangement of the shutter is another matter which has required careful consideration. In the plan adopted I have aimed at securing the conditions:—(1) that there should be a wide opening, (2) that the shutter should open easily, (3) that it should present a symmetrical appearance externally, and (4) that the opening should be of the same width throughout on both sides of the zenith, so as to allow the air to pass freely through in the neighbourhood of the object-glass. The shutter, as arranged, is in two parts, with a division right down the middle, each half being a balanced shutter, 3 feet 6 inches wide, which extends right over the dome from the curb, through the zenith to the opposite part of the curb, and traverses to one side on a narrow rail (about 13 feet long) at the zenith, and on two broad rails attached to the opposite part of the curb at the bottom of the shutter on each side of the zenith. Each half of the shutter runs on a double-flanged bearing-wheel (say 1 foot in diameter), which it carries nearly vertically over its centre of gravity (so that it nearly balances on it, leaving a small excess of weight on the outer side), and it also carries a smaller double-flanged guiding-wheel on a stiff tail-piece, extending across the shutter opening to the other end of the rail. The flanged bearing-wheel runs on the upper side of the rail, and the guiding-wheel on the under side, so that it does not interfere with the bearing-wheel of the other half of the shutter. The tail-pieces (about $7\frac{1}{4}$ feet long) are bolted to the edges of their respective shutters on either side of the zenith, so that they run clear of each other when the shutters are opened. To guard against the possibility of the shutter being lifted by the wind, the tail-pieces may carry a supplementary roller (between the bearing and guiding rollers) running clear below the rail and just above a guard-rail fixed below it. The rail and the bearing and guiding wheels are under the shutter and covered by it when closed. Near the zenith the parallel curved girders of the shutter-opening, and the parallel outside edges of the shutters, are replaced by arcs of an horizontal circle (say 13 feet in diameter), allowing space under this part of the shutter for the rail (13 feet long), wheels, and guiding-pieces. Thus an opening,

7 feet clear throughout on both sides of the zenith, can be obtained when the shutters are opened to their fullest extent. The arrangement adopted for the tail-pieces in combination with the circular form of the shutter near the zenith, allows of a greater length in the guide for traversing the shutter. The weight of the shutter is carried chiefly by the bearing-wheel at the zenith, and in a small degree by wheels (without flanges) at the bottom of the shutter on each side of the zenith, which run on rails without lateral constraint, and serve to maintain the balance. Horizontal rollers (with flanges underneath) mounted on the same brackets would also serve for this purpose, and as wind-guards to prevent the shutter being lifted by the wind. The shutters may be opened and shut by means of tackles attached near the zenith.

The figures show the general arrangement of the dome. Fig. 1 is a sectional elevation of the dome and tower, showing the divided shutter, the circular girder with vertical and horizontal rollers, and the horizontal circular ribs. The two semi-circles (dotted) are the generating circles of the involute. The position of the centre of the equatoreal is indicated by a cross. Fig. 2 is a plan of the dome, above the equator, showing the vertical and horizontal ribs, the broad-flanged connecting-rib, and the shutters with the tail-pieces, rollers, and rail. The dotted circle represents the 28-inch object-glass pointing to the zenith. Fig. 3 is a vertical section showing the shutters with the tail-pieces, rollers, and rails, at the zenith and at the bottom. The dotted lines indicate the position when the shutters are open. The three rollers connected by lines are attached firmly to the left-hand shutter, the upper left-hand and lower right-hand rollers being double-flanged wheels which run on the upper and under sides of the upper rail respectively, and the intermediate (lower) roller being a guard-wheel between the upper and lower rails to prevent the other two wheels being thrown off the rail by the action of the wind. The rollers at the bottom are without flanges, and are carried by brackets, so that when the shutters are opened they pass clear behind the vertical girders of the opening, and run on a rail fixed on the circular girder entirely within the dome.

Royal Observatory, Greenwich :
1891 May 7.

Photographs of Neptune and its Satellite. By Isaac Roberts, F.R.S.

Sixteen photographs of the planet *Neptune* were taken at my observatory between December 9, 1890, and February 24, 1891, with exposures of the plates varying between fifteen minutes and three hours respectively. Upon eight of the plates the satellite is to be seen, and I have prepared the accompanying diagram to show its positions by measurements of the eight plates. The diameter of the photographic image of *Neptune* in my telescope is about equal to the major axis of the projected orbit of the satellite. The satellite can, therefore, be photographed only when it is somewhere within the distance of about 45° of the line of apsides, and if the planet did not mask the satellite in the other parts of its orbit the orbital motion would be too rapid to permit a photographic image being formed.

The large circle, fig. 1, represents the photographic image of *Neptune*, and the eight small circles around it those of the satellite. It is difficult to measure with accuracy the position angles of the satellite, because its image is generally very faint and undefined in outline by reason of the orbital motion; and the relatively large image of the planet adds to the difficulty in finding the line joining their centres. The position angles given in the following table are the nearest approximations practicable under these conditions.

Approximate position angles of the satellite :—

No. 1, 1890, December 9, exposure 3 hours; sidereal time, 5h. 25m....	$59^\circ 28'$
No. 2, 1890, December 12, exposure 15 minutes; sidereal time, 4h. 59m.	$232^\circ 40'$
No. 3, 1891, January 10, exposure 60 minutes; sidereal time, 4h. 14m.	$261^\circ 46'$
No. 4, 1891, February 1, exposure 84 minutes; sidereal time, 5h. 31m.	$31^\circ 29'$
No. 5, 1891, February 4, exposure 50 minutes; sidereal time, 5h. 4m.	$207^\circ 6'$
No. 6, 1891, February 10, exposure 75 minutes; sidereal time, 6h. 5m.	$193^\circ 55'$
No. 7, 1891, February 20, exposure 90 minutes; sidereal time, 6h. 54m.	$277^\circ 3'$
No. 8, 1891, February 24, exposure 75 minutes; sidereal time, 6h. 45m.	$44^\circ 53'$

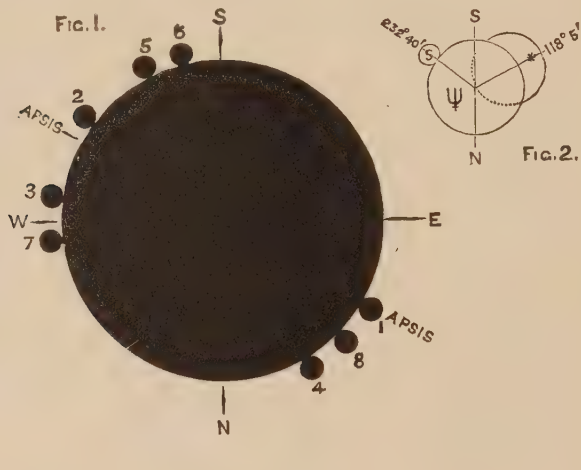
The sidereal time given in the above table is that at the middle of each exposure for the meridian of Crowborough, 37° East of Greenwich.

On December 12, 1890, *Neptune* was in conjunction with the star D.M., $+19^\circ 699$, R.A. $4^h 11^m 17^s.5$, dec. $+19^\circ 24'6$, mag. 9.4, and the relative positions of the star, planet, and satellite are shown on the diagram, fig. 2. At sidereal time $4^h 59^m$ the position angle of the planet and star was $118^\circ 5'$, and that of the satellite $232^\circ 40'$. The distance of the planet and star, measured from centre to centre, was $10''.85$ of arc. The

measured photo-diameter of the planet was $12''.21$, and of the star $9''.5$.

In the event of any computations being made touching the subject of this communication, the sixteen negatives referred to will be available for measuring positions and distances between the planet and the surrounding stars during the opposition of *Neptune* in 1891.

The photographs do not indicate the existence of any other satellite than the one discovered by Lassell.



Photograph of the Region of Hind's Variable Nebula in Taurus.
By Isaac Roberts, F.R.S.

In November last year Mr. Burnham, of the Lick Observatory, drew my attention to the region of Hind's Variable Nebula in Taurus, and informed me that he had searched the region with the 36-in. refractor and found what appeared to be a small star placed within a very small condensed nebula, the nebula being elongated in the direction of $151^{\circ}.7$. A rough reading of the wires gave $4''.4$ for the length of the nebula.*

The photograph does not show any nebulosity or nebula or nebulous star anywhere about the region here referred to, though the exposure extended during three hours, and therefore nebulosity of a much fainter character than that shown in the *Pleiades* should have appeared on the photograph.

I am not suggesting that there can be any error in the observations made at the Lick Observatory, but the absence of any trace of nebulosity on the photograph may point to some rapid

* *Monthly Notices, R.A.S.*, vol. li. p. 94.

changes having taken place in the object between October 15, 1890, when observed at Lick, and December 9, when the photograph was taken. I am sending a copy of the photograph to Mr. Burnham, with the object of assisting to clear up what is now obscure.

The position of the nebula and of Hind's variable (R.A. $4^h 14^m 58^s$, $D + 19^\circ 14'$) is indicated within the larger of the white circles drawn on the photograph, and within the smaller white circle is the planet *Neptune* shown with its satellite.

The satellite is very strongly imprinted on the film of the negative as a black spot, and this is itself an indication of the faintness of the luminosity required to make an impression on the photograph.

Photograph of the cluster 44 M. Cancri (the Præsepe). By Isaac Roberts, F.R.S.

The photograph now presented is an enlargement to three and a half times from a negative which was taken on February 13, 1891, and is intended to serve as a chart of the stars between R.A. $8^h 30^m$ and $8^h 38^m$, declination N. $19^\circ 19'$ to $21^\circ 19'$, covering four square degrees of the sky. The exposure was given during ninety minutes in the 20-in. reflector. The negative shows many faint stars that cannot be copied on the enlarged photograph, and I propose to engrave (direct from the negative) this and some other clusters, as illustrations of the advantage of the engraving process over the photographic in showing all the stars, including the faintest, that may be on any negative and in eliminating from the chart specks on the film that would in any photo-printing process appear as, and be mistaken for, stars.

The photographs illustrating the above three communications are placed in the Library.

On the character of the chief line of the Nebula in Orion.

By Kavasgee D. Naegamvala, M.A.

Mr. Lockyer bases the claim of the chief nebula line to belong to magnesium, on the ground first that according to his observations it is exactly coincident with the first magnesium fluting, and secondly that it has the character not only of the remnant of a fluting, but of the fluting of magnesium, inasmuch as the line has been observed by him and by others to be *less* well defined on the violet side than on the red.

The recent researches of Dr. and Mrs. Huggins, followed by those of Mr. Keeler, have shown that the claim of perfect coincidence with the first magnesium fluting advanced by Mr. Lockyer for the chief nebula line is not tenable, while the fluted character of the line itself has been very much called in question of late.

Mr. Lockyer in his "Meteoritic Hypothesis" states that "observations of nebulae should show that a fluting and not a line is in question," and as for instrumental means to be employed for this particular purpose he remarks that "high dispersion is not so likely to show the fluted character of the chief line as low."

I have therefore felt that the instrumental means at my disposal were well suited for a determination of the *character* of the line in question, and I have with that view examined the *Orion* nebula on numerous occasions during the last two months.

The telescope employed has been a silver-on-glass Newtonian by Sir Howard Grubb of 16½-inch aperture, while three different spectroscopes have been successively brought to bear upon the nebula. The first one employed was a direct-vision McClean Spectroscope, by Browning, with a slit opening only in one direction; while the second instrument was a rain-band spectroscope by Negretti and Zambra, provided with an eye-piece and easily, though not very widely, separating the D line; the slit of this spectroscope was also made to open only in one direction. The third spectroscope was a star single prism spectroscope by Grubb of his well-known form, with this difference, that, instead of the usual compound prism, a large prism of flint was substituted; the lenses of this spectroscope are an inch and a half in diameter, the telescope is provided with a battery of four eye-pieces, and the slit opens equally in both directions. The instrument gives spectra of exceptional brilliancy and of great definition.

Neither of the three spectroscopes has revealed any "fluted" characteristics in the chief line. On several occasions the line was observed not only well defined but *very sharp* and clear cut, having all the characteristics of a line proper; while any want of definition or clearness—in other words, the existence of any

raggedness—on one side was accompanied by a similar appearance on the other. The slit of the rain-band spectroscope was turned through 180° without changing the character of the line. With the Grubb spectroscope the whole battery of eye-pieces was successively employed and the width of the slit was varied through the fullest extent. Any widening of the slit invariably broadened the line *equally* in both directions *without any falling off in intensity on the violet side*, and in this particular the other two lines behaved precisely in the same fashion as the “chief line,” all three being in the same field of view.

After a most careful examination, therefore, of the line in question, I have been forced to come to the conclusion that it does *not* reveal to me the character of “the remnant of a fluting” of magnesium.

I propose shortly to examine the chief line of the nebula from the point of view of coincidence by the siderostatic method.

College of Science, Poona:
1891 March 20.

Erratum in Radcliffe Observations of Iris Comparison Star.

Arg. Z. + 20° , 341 (*Monthly Notices*, vol. xlix. 7, p. 392 and p. 396).
For $69^\circ 9' 1''.59$ read $69^\circ 9' 3''.55$.

